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The Network Concepts Class: A Case Study in Developing A New Curriculum Model

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Introduction

The Computer Information Systems (CIS) program at the University of Southern Colorado (U.S.C.) is designed to prepare its graduates to function in a wide variety of roles within the information systems (I.S.) domain. The faculty, students, and employers feel that preparation for any foreseeable entry-level position a graduate is likely to encounter is of utmost importance in the design and development of the curriculum. This paper reports on the efforts undertaken while, and the outcomes achieved from, addressing an employer-identified problem with our network concepts class. The next section discusses the motivation for undertaking the development of a new model. Succeeding sections relate a description of the process used to develop and implement the new model, identified benefits from implementing it, and future suggestions for refinement and to others considering adopting the model.

Motivation

The CIS program is part of the engineering college at the university and evolved over the years from a pure computer science program. In its current format, the program focuses on preparing students to develop and manage applications of information technology to meet organizational needs and solve problems. Consequently, faculty members strive to focus the content of each class on providing knowledge and skills directly applicable to situations the graduates experience as they enter the workforce. The problem with our network concepts class resulted from the failure of student learning in the class to match employer needs and expectations.

All I.S. programs at the university level face the same conundrum. The I.S. field is growing and changing at such a rapid rate, it is impossible to keep courses totally up-to-date and to teach everything graduates need to know when entering the I.S. workforce. As a result, developers of I.S. curriculums must pick and choose what to include in their course offerings, which classes to designate as required, and which to allow students to self-select. Those programs associated with AACSB-accredited business schools face additional pressures from the necessity of fitting their I.S. program within the confines of the hours available after the business-core requirements are met.

The explosive growth of the Internet has only reiterated the need for I.S. graduates to understand the concepts and techniques of networking. Along with most

other I.S. programs, the CIS program at U.S.C. has required an introduction to networking concepts class for many years. As the name implies, the class was conceptual in nature and addressed the fundamental aspects of networking. These included discussions of what a network is, why networking benefits organizations, design issues, topologies, the OSI model, communication protocols, hardware requirements, and management/control issues.

Although the class gave the students a conceptual understanding of networking, the student reaction to the course, as measured by evaluations and comments, was mediocre at best. The students did not come out of the class with any knowledge they felt would directly help them when they walked on their first job. The truth of the students' feelings was confirmed through an employer conversation during the early summer of 1998.

The author had the opportunity to discuss one of our recent graduates in the performance of what should have been a very simply task involving installation of an operating system on a workstation. The employer had contracted with the graduate to install Windows NT 4.0 Workstation on a number of computers and connect them to a Windows NT 4.0 server over a network. The employer was very disappointed with the graduate's performance and terminated the contract early. The employer commented that the graduate knew the concepts of what needed to be done, but did not understand how the concepts related to actually performing the task.

I related this conversation to several other members of the department. They all knew the graduate. Although the graduate was not one of our stronger students, we all asked the question: "How could this happen?" More importantly: "What did this say about what our students are taking away from our classes?"

Further investigation revealed that the graduate in question had taken all of the networking classes our department offered (two classes in addition to the introductory class) and performed well in all of them. Examination of the content of the courses taken revealed that the graduate was not prepared for the task because none of the courses required starting with essentially a clean sheet, from scratch. We on the faculty had not created an experience in the curriculum that provided the type of knowledge necessary for success in this type of endeavor, one all of our graduates can expect to encounter.

We did some other self-reflection and discovered that we on the faculty had learned our craft during a time when doing everything required to set up and configure a new computer yourself was expected. We were taking for granted that our students had this type of experience also. However, this assumption is not appropriate in today's context. Most machines are purchased from the manufacturer with operating systems and peripherals installed and operating. As a result, many students do not experience the problems that can result from attempting to install and configure operating systems and peripherals on a computer. We asked ourselves, "What can we do about that?"

An additional question involved what is learned in required versus non-required classes? The graduate in question had taken several classes in addition to the required class and still was not prepared. What about those students who take other electives and do not take the advanced networking classes? Should the curriculum provide a basic level of this type of knowledge to all students, regardless of the electives selected? Given the likelihood that all businesses our graduates will enter are, or will be, networked, is being able to install an operating system and connecting it to a network a basic skill that all CIS graduates should possess?

We decided that the answer to this question is yes. We as a faculty cannot claim that our graduates are competent to perform in entry-level I.S. positions without this level of basic knowledge. As the person teaching the networking classes, I was tasked with finding a workable solution.

Process

It was important that any solution to this dilemma provide the students with both a working understanding of the concepts of networking and a modicum of hands-on skills in the performance of network-related tasks. To increase the likelihood of success, I used a simplified version of the traditional Systems Development Life Cycle model (Burch, 1992; Whitten & Bentley, 1998).

The first step was to analyze the tools available to solve the problem. The CIS department at U.S.C. has a separate computer lab dedicated to networking instruction. It was originally created with a grant from the National Science Foundation and has been updated periodically with newer equipment. Its current configuration is 18 Pentium-based student machines, 3 Pentium-based servers, one Pentium-based instructor workstation, a laser printer, and a UPS system.

The student computers are sufficiently powerful to run any of the current generation Microsoft operating systems. Each of these systems (Windows 95, Windows NT 4.0 Workstation, and Windows NT 4.0 Server) can be

used to demonstrate the implementation of networking concepts.

The network concepts class is taught in this room. Historically, however, the only use of the computers was to demonstrate concepts and hardware through the use of a system which broadcasts the information on the instructor workstation screen to the screens on the student machines. Little or no interaction occurred between the students and the computers. The actual use of the computers for networking occurred in the advanced classes.

The second step was to design a class format which would both introduce and discuss the various concepts of networking while also providing the students with practical experience in the network installation process. A supplemental goal was to prepare the students for a definitive measure of the network knowledge.

The Microsoft products mentioned earlier come with networking capabilities built-in. Windows 95 can implement peer-to-peer networks natively, while containing the ability to act as a client to Microsoft, Novell, and Apple/Macintosh networks. Windows NT 4.0 Workstation has the same capabilities. Windows NT 4.0 Server can act as a server to Microsoft, Novell, and Apple/Macintosh workstations. It can also act a gateway between these network operating systems. Understanding and working with the capabilities of these operating systems is a valuable method of illustrating the various concepts and methods of networking.

The class design had to integrate the hands-on projects with the conceptual content without making the workload onerous. Additionally, I wanted to make the projects challenging to the students, whatever their background before entering the class. The final design involved the following projects:

1. Install Windows 95 operating system from scratch;
2. Create a peer-to-peer network with other student computers;
3. Add capability to act as a client to a Netware server;
4. Install Windows NT 4.0 Workstation and duplicate Windows 95 installation (i.e. peer-to-peer with client to Netware server)
5. Add Windows NT 4.0 Server client capability to NT Workstation.

Table 1 details how the projects address the various networking concepts covered in the class.

The development process involved setting up the machines in the lab with the appropriate configuration of software and hardware to implement the design. In order to add elements of realism to the process, and force the

students to think about what they were doing and not rely on the automated steps built into the Windows 95/NT setup programs, various stumbling blocks were included that required problem-solving skills to overcome. Examples included the inclusion in the computers of network interface cards that the software could not automatically detect and configure and the use of non-standard group and domain names.

Networking Concepts	Concept Addressed by Project				
	Windows 95 Installation	Create Peer-to-Peer	Connect to Network Server	Install NT4 Workstation	Connect to NT4 Server
Design Essentials		X	X	X	X
Networking Media		X		X	
Network Interface Cards	X			X	
OSI Model		X	X	X	X
Communication Protocols		X	X	X	X
Network Architectures		X		X	
Network Operating Systems	X	X		X	X
Interoperability			X	X	X
Network Administration		X	X	X	X
Distributed Networks			X		X
Wide Area Networks			X		X
Troubleshooting	X	X	X	X	X

The implementation of the design took the entire fall semester. As with any new design, unforeseen nuances occurred. One of the joys of working with computer hardware and software is that they seldom interact as the manufacturers state. Consequently, some time was spent identifying inconsistencies in hardware and software operation. Refinement of assignment wording was necessary to accommodate different interpretations. Due to the number of students, the projects were performed in teams, which also caused some variations in project results and completion rates.

Benefits

Question	Fall, 1997	Fall, 1998
Work assignments give new knowledge	4.1	4.1
Assignments intellectually challenging	3.8	3.8
Lab experiments effective	3.6	4.1

(5 point scale; 5 - high, 1 - low)

The network concepts class has traditionally been one of the least desirable of the required classes. Although various instructors taught the class, it was difficult to get the students motivated or for them to find real value in the subject matter. Table 2 shows that while they were covering new material which challenged them, their evaluation of the practical value of the assignments was less than favorable. However, implementing the new model with hands-on illustration of the concepts and

methods of networking appears to have had a significant impact on the students' evaluation of the effectiveness of their learning experience.

The only difference between these evaluations is the change to the use of hands-on projects. The instructor and the underlying subject matter is the same for both semesters. The Fall, 1998, written comments also included positive comments on the impact of the hands-on projects to the overall learning experience. Examples include "hands on projects good learning experience" and "I feel it was a total learning experience even when emotions are high".

Future Suggestions

This experience demonstrated that it is important to truly engage students in the learning process. In the world of constant change into which we send our students as products of our programs, it is important to provide them with the tools they will need to survive and thrive. Most of them have grown up in an environment of constant change, which causes them to question the immediate and future usefulness of everything we attempt to teach them. The results of this class redesign project show that telling students a fact and then showing them how to use it is indeed a most valuable learning method. The future direction envisioned for this class is to increase its real world content by bringing in more aspects network design and implementation where the students design the network based upon their evaluation of the organization information needs.

For those contemplating adoption of a similar model for the network concepts class, the most important idea is the engagement. Merely introducing ideas without providing interaction and application is unlikely to have significant benefits. It is probably not necessary to get as complicated as we have been here if you do not have facilities available. Even the simple peer-to-peer network serves as an excellent vehicle for illustrating the various components necessary to make a computer network operate successfully. Engage them with action any way you can.

References

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